International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 6 Issue 04, April-2017

Retinal Blood Vessel Extraction using ISODATA Clustering and Morphological Operations

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***Abstract*— In medical image processing, retinal image analysis vital for the analysis of anomalyse like diabetics retinophathy like Glaucoma. This project proposed a retinal blood vessel segmentation algorithm based on morphological operations and ISODATA clustering technique. The preprocessing input image was done using adaptive histogram equalisation and average filtering. The ISODATA algorithm were employed for the segmentation and post-processing was done by morphological operations. This algorithm was developed in MATLAB 2010a and images are tested from drive and stare database.**

Keywords: Diabetic Retinopathy, Fuzzy C-Means, Adaptive Weighted Morphological Functor, Iterative Self-Organizing Data Analysis Technique, Contrast Limited Adaptive Histogram Equalization, fundus imaging, drive, stare, diabetic retinopathy.

I. INTRODUCTION

An image is a 2D signal, processed by the human visual system. The signals representing images are in analog form. However, for processing, storage and transmission they are converted from analog to digital form. Use and dependence on information continue to grow, so there is a need of storing and transmitting large amounts of data efficiently. Image segmentation is often an essential step in image analysis, object representation, visualization and many other image processing tasks.

Yong yang et al [1] proposed a mathematical morphology and fuzzy clustering algorithm for retinal blood vessel extraction.This extraction can produce identical results as the ground truth and produce a higher accuracy ratio and a lower misclassification ratio. Kavya K et al [2] proposed an automated retinal blood vessel segmentation approach based on Fuzzy C-Means(FCM) clustering and then perform the extraction using Artificial Bee Colony optimization to improve the accuracy of segmented image. Martin [3] proposed a novel topological segmentation ie varilets. It provides high-resolution images for processing piecewise linear boundary components in the real image plane.Yuji Hatanaka et al [4] proposed an automated blood vessel extracted using high-order local autocorrelation(HLAC). The outputs were evaluated using the area under the curve(AUC). Divya A Sajjan [5] proposed the extraction of retinal blood vessel for diagnosing disease which is easy,simple,reliable,high accurate and efficient for extraction of blood vessels and detecting the bifurcation points of extracted blood vessel.

Saleh Shahbeig, Mohammad Sadegh Helfroush [6] proposed an Adaptive Weighted Morphological Functor (AWMF) method for the extraction of blood vessels.This method mainly uses the principle component analysis (PCA) technique and estimation of the brightness and contrast of the background, that effectively eliminates the interference of regions with intense brightness structure from the background light distribution. Ishmeet Kaur & Lalit Mann Singh [7] proposed the segmentation approach that achieved the average accuracy of 98.7% whereas the diseased image was detected with 99% accuracy.

Vaibhavi B. Patil [8] proposed the Unsupervised Texture Classification from Color Retinal Images. The Fuzzy C-Means (FCM) clustering algorithm is used to classify the feature vectors into vessels or non-vessel based on the texture properties. Vijaya Shanthini.K. and Vinothini.K.R [9] proposed the retinal blood vessel segmentation and detection using k-means and morphological clustering. Here, the blood vessels are classified to extract the retinal image vessels for computer based retinal image and also k-means and morphological clustering are used to enhance and smooth the retinal images. Section II describes the proposed system. Section III describes the results and discussion and finally conclusions are drawn in section IV.

II. PROPOSED SYSTEM

Analysis of the retinal blood vessels from fundus images has been widely used by the medical community for diagnosing complications due to hypertension, arteriosclerosis, cardiovascular disease, glaucoma, stroke, and diabetic retinopathy (DR) Automated blood vessel segmentation systems can be useful in determining variations in the blood vessels based on the vessel branching patterns, vessel width and vessel density as the pathology progresses in patients.

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The Iterative Self-Organizing Data Analysis Technique (ISODATA) method used a set of rule-of-thumb procedures that have incorporated into an iterative classification algorithm. The steps in proposed system are as follows:

- Input the RGB retinal image and convert the input image as gray.Image localized contrast enhancement through CLAHE.
- Take difference image of average filtered image and input image for removal of abnormalities/geometrical objects, e.g. optic disc, macula, and bigger structures.

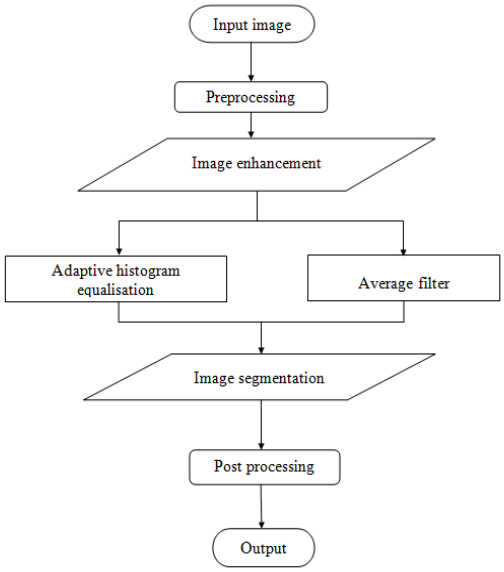

Figure 1: Block diagram of the proposed system

- For an average filter, selected kernel size is more than vessel's diameter size. This also makes the edges more prominent than the background.
- Segmentation based on the implementation of ISODATA.
- Execution of postprocessing using morphological operations.

A. *Image Preprocessing*

The image is pre-processed to enhance the quality of image and to make the further calculations easy and productive. The different steps of image preprocessing include resizing, doubling, unsharp masking, contrast enhancement and calculation of image gradient magnitude. Image pre-processing are a set of techniques to improve the visual appearance of images. Image pre-processing can significantly increase the reliability of an optical inspection. Major pre-processing techniques used here are: resizing, doubling and type change.

B. *Image enhancement*

Adaptive histogram equalization

Adaptive histogram equalization (AHE) is used to improve contrast in images and it differs from ordinary histogram equalization. Ordinary histogram equalization uses the same transformation derived from the image histogram to transform all pixels.

However, AHE has a tendency to over amplify noise in relatively homogeneous regions of an image. A variant of adaptive histogram equalization called contrast limited adaptive histogram equalization (CLAHE) and used as a contrast limiting.

Average filter

The most common linear smoothing algorithm is the mean filter, and it is probably the most popular filter amongst interpreters. Typically, the weights in the kernel are uniform but they can also be triangular. The output was given as 5 × 5 uniform mean filter.

Clearly, there is significant noise remaining in the horizon: this filter is not well suited to noise reduction. The problem is that noisy pixels including anomalous spikes are weighted the same as all the other pixels in the kernel.

C. *Image segmentation*

Image segmentation is defined as the process partitioning a digital image into multiple segments. The aim is to simplify or change the representation of an image into a meaningful and easier. It is mainly used to locate objects and boundaries in the images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain characteristics.

The output of image segmentation is collectively cover the entire image, or a set of contours extracted from the image. Each of the pixels in a region are similar with respect to some characteristic or computed property, such as color, intensity, or texture. Adjacent regions are significantly different with respect to the same characteristic.

ISODATA: Iterative Self-Organizing Data Analysis Technique Algorithm

The ISODATA algorithm is essentially a refinement of the K-Means algorithm. The specific refinements are:

1) Clusters that have too few members are discarded.
2) Clusters that have too many members are divide into two new cluster groups.
3) Clusters that are too large (too disperse) are divide into two new cluster groups.
4) If two cluster centers are too close together they are merged.

D. *Post processing*

Binary images may contain numerous imperfections. Post processing of an image means performing some morphological operations to the image. Morphological operations applies a structuring element to an input image, creating an output image of the same size. In a morphological operation, the value of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbours. By choosing the size and shape of the neighbourhood, you can construct a morphological operation that is sensitive to specific shapes in the input image.

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The most common morphological operations are dilation and erosion. Dilation means to add the pixels to the boundaries of objects in an image, while erosion removes pixels on object boundaries. Depends on the size and shape of the structuring element the number of pixels are added and removed from the objects. In the morphological dilation and erosion operations, the state of any given pixel in the output image is determined by applying a rule to the corresponding pixel and its neighbours in the input image. These operations are used to define the clear boundaries of segmented output image.

III. RESULTS AND DISCUSSION

The images used for validation of the proposed approach are obtained from publically available DRIVE (Digital Retinal Images for Vessel (Extraction) and STARE (Scandinavian Twin Auroral Radar Experiment). The DRIVE database consists of 40 colour fundus images.

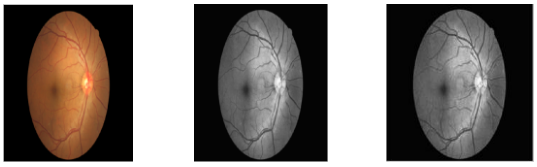

Figure2: (a)Input image, (b)Conversion of RGB to gray image, (c)CLAHE, (d)Average filter, (e)Convert ISODATA to binary, (f)Output image

Figure2:(a)The Input image is retinal blood vessel of human, which is viewed from the fundus camera. Figure2:(b)Then the retinal blood vessel input image is converted into gray image. Figure2:(c)CLAHE differs from adaptive histogram equalization can also be applied to global histogram equalization, giving rise to contrast limited histogram equalization (CLAHE). Figure2:(d)The mean filter is a simple sliding-window spatial filter that replaces the center value in the window with the average (mean) of all the pixel values in the window. Figure2:(e)Then ISODATA algorithm is applied to the image and converted into binary. Removes all connected components (objects) that have fewer than P pixels from the binary image BW, producing another binary image, BW2. BW2 removes all connected components, where conn specifies the desired connectivity. Figure2:(f)Segmentation of retinal blood vessel is obtained.

IV. CONCLUSION

The major problem of patients are suffering from eye problems like diabetic retinopathy. It affects up to 80 percent of people who have had diabetes for 20 years or more. To overcome that we are using several techniques. In this paper we are proposing the ISODATA algorithm for the segmentation and post-processing method was done by morphological operations.

ACKNOWLEDGMENT

The authors we would like to acknowledge the support provided by DST under IDP scheme (No: IDP/MED/03/2015). We thank Dr Sebastian Varghese (Consultant Radiologist, Metro Scans & Laboratory, Trivandrum) for providing the medical CT images and supporting us in the preparation of manuscript.

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